

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior listings of claims in the application.

Listing of Claims

1-18. (Cancelled)

19. (New) A process for treating the boundary walls of an interior chamber formed in a workpiece, comprising the steps of:

providing a workpiece having an interior chamber;

providing the workpiece with a plurality of said interior chambers which are sidewardly spaced apart and transversely interiorly interconnected, and first and second aligned access openings communicating with opposite ends of each respective interior chamber;

providing pluralities of first and second nozzle members positioned so that each of said first nozzle members is disposed in opposed relationship to a corresponding one of said second nozzle members;

simultaneously inserting all of said first nozzle members into the workpiece and also simultaneously inserting all of the second nozzle members into the workpiece so that each of the opposed pairs of first and second nozzle members is positioned within a respective one of the interior chambers and discharge openings of the opposed first and second nozzle members are positioned closely adjacent and directly opposed to one another;

simultaneously supplying substantially equal streams of pressurized blasting media, as defined by a pressurized carrier fluid having solid abrasive particles entrained therein, to the discharge openings of all of the first and second nozzle members;

simultaneously discharging substantially equal and opposed high-velocity streams of blasting media from said discharge openings so that the discharged streams, almost immediately after discharge, directly impact one another to cause the blasting media to be deflected radially outwardly in a surrounding annular pattern for high energy impact with the boundary wall of the respective interior chamber; and

simultaneously moving the nozzle members, while maintaining them in generally fixed relationship to one another, along the respective interior chamber so that the blasting media as deflected radially outwardly into the annular pattern progressively treats the boundary wall of the respective interior chamber.

20. (New) A process for treating the boundary walls of an interior chamber formed in a workpiece, comprising the steps of:

providing a workpiece having an interior chamber;

providing the workpiece with a plurality of said interior chambers which are sidewardly spaced apart and transversely interiorly interconnected, and first and second aligned access openings communicating with opposite ends of each respective interior chamber;

providing first and second nozzle members with opposed discharge openings;

aligning said first and second nozzles with opposite ends of a first one of said interior chambers and then inserting said nozzles into the chamber with a defined small gap between the opposed discharge openings thereof;

synchronously moving the first and second nozzle members linearly along the chamber while supplying substantially equal streams of pressurized blasting media, as defined by a pressurized carrier fluid having solid abrasive particles entrained therein, to the discharge openings of said nozzle members to simultaneously discharge substantially equal and

opposed high-velocity streams of blasting media from said discharge openings so that the discharged streams, almost immediately after discharge, directly impact one another to cause the blasting media to be deflected radially outwardly in a surrounding annular pattern for high energy impact with the boundary wall of the chamber;

thereafter withdrawing the first and second nozzle members from said opposite ends of the first chamber and transversely displacing the first and second nozzle members relative to the workpiece so that the nozzle members align with opposite ends of a second one of said interior chamber; and

thereafter inserting the nozzle members into the second interior chamber and effecting treatment of the boundary wall thereof in the same manner as with respect to the first chamber as defined above.

21. (New) An apparatus for treating boundary walls of an interior chamber formed in a workpiece and which is accessible through first and second access openings which access opposite ends of the interior chamber, said apparatus comprising:

a fixture for positioning the workpiece thereon;

first and second nozzle assemblies positioned on opposite sides of the fixture and respectively including first and second elongate nozzle members which are disposed in generally aligned but opposed relationship, said first and second nozzle members being positioned for insertion through the respective first and second access openings associated with the workpiece when the workpiece is mounted on the fixture;

first and second movable supports which respectively mount the first and second nozzle assemblies thereon;

first and second drive devices interconnected to the respective first and second supports for effecting movement of the respective nozzle assembly from a retracted position wherein the respective nozzle member has a discharge end

thereof spaced from the workpiece and an operational position wherein the respective nozzle member is inserted through the respective access opening so that the discharge opening of the nozzle member is positioned within the interior chamber;

said first and second supports and the respective first and second nozzle assemblies mounted thereon being synchronously movable, while maintaining a substantially fixed spatial relationship between the opposed discharge openings of the nozzle members, to effect movement of the discharge openings within the interior chamber; and

a supply source connected to each of the first and second nozzle members for simultaneously supplying substantially identical pressurized streams of carrier fluid and abrasive particles to both nozzle members for effecting simultaneous discharge from the nozzle members of opposed high-velocity streams of abrasive media defined by said carrier fluid having said abrasive particles entrained therein, whereby the opposed discharged streams directly impact one another within the interior chamber to cause the streams to be deflected radially outwardly in an annular pattern for high energy impact against the boundary walls of the interior chamber.

22. (New) An apparatus according to Claim 21, wherein each of said nozzle members comprises an elongate tubular member having said discharge opening at one end thereof.

23. (New) An apparatus according to Claim 22, wherein said discharge opening is defined within a carbide tip member.

24. (New) An apparatus according to Claim 21, wherein the first and second nozzle assemblies includes plural opposed pairs of first and second nozzle members which are insertable through respective access openings of the workpiece for association with different portions of the interior chamber, the plurality of first nozzle members as well as a plurality of second nozzle members being disposed in generally parallel

but sidewardly spaced relationship and being simultaneously movable as a unit.

25. (New) An apparatus according to Claim 21, wherein each of said first and second supports is mounted for generally linear movement in a direction which is generally parallel with an axis which extends through the interior chamber and aligns with the first and second access openings.

26. (New) An apparatus according to Claim 25, wherein the second support is linearly movably supported on the first support for movement with respect to the first support along a direction which is generally parallel with said axis.

27. (New) An apparatus according to Claim 26, wherein said first drive device is drivingly coupled between said first support and a stationary housing, and wherein said second drive device is drivingly coupled between said first and second supports, whereby activation of said first drive device causes simultaneous linear movement of said first support and said second support.

28. (New) An apparatus according to Claim 21, including a housing structure which includes walls functioning as a shroud for defining therein a treating chamber, said fixture being positioned within said treating chamber, and said nozzle assemblies being disposed on opposite sides of the shroud so that the nozzle members movably project through the shroud for disposition within opposite sides of the treating chamber.

29. (New) An apparatus according to Claim 21, wherein the first and second nozzle assemblies and the respective first and second drive devices are mounted on a transverse movement assembly which permits the first and second nozzle assemblies to be simultaneously transversely displaced relative to the workpiece to permit the nozzles to be

sequentially positioned in alignment with different interior chambers of the workpiece.

30. (New) An apparatus according to Claim 21, wherein one of the first and second drive devices has a speed control arrangement associated therewith for varying the speed of movement of the synchronously-moveable first and second nozzles as they linearly traverse the length of the interior passage.

31. (New) An apparatus according to Claim 21, wherein each of said first and second nozzles comprises an elongate nozzle member having a discharge passage extending lengthwise over a significant length thereof and terminating in a discharge opening at one end of the nozzle member, said discharge passage having a length of at least about 8 inches and a maximum diameter of about 1/4 inch.

32. (New) An apparatus according to Claim 21, wherein the distance between the opposed discharge openings of the nozzle members is about one inch.

33. (New) An apparatus according to Claim 21, wherein the distance between the opposed discharge openings of the nozzle members is about one half inch or less.

34. (New) An apparatus according to Claim 21, wherein the distance between the opposed discharge openings of the nozzle members is about 0.100 to about 0.300 inches.

35. (New) An apparatus according to Claim 21, wherein said first and second nozzle assemblies each having an orifice that emits a cylindrical stream of blasting fluid.

36. (New) An apparatus according to Claim 21, wherein said first and second nozzle assemblies are identical.

37. (New) An apparatus for treating boundary walls of an interior chamber formed in a workpiece and which is accessible through first and second access openings which access opposite ends of the interior chamber, said apparatus comprising:

- a fixture for positioning the workpiece thereon;

- first and second nozzle assemblies positioned on opposite sides of the fixture and respectively including first and second elongate nozzle members which are disposed in generally aligned but opposed relationship, said first and second nozzle members being positioned for insertion through the respective first and second access openings associated with the workpiece when the workpiece is mounted on the fixture;

- first and second movable supports which respectively mount the first and second nozzle assemblies thereon;

- a drive arrangement interconnected to the respective first and second supports for effecting movement of the respective nozzle assembly from a retracted position wherein the respective nozzle member has a discharge end thereof spaced from the workpiece and an operational position wherein the respective nozzle member is inserted through the respective access opening so that the discharge opening of the nozzle member is positioned within the interior chamber;

- said first and second supports and the respective first and second nozzle assemblies mounted thereon being synchronously movable, while maintaining a substantially fixed spatial relationship between the opposed discharge openings of the nozzle members, to effect movement of the discharge openings within the interior chamber; and

- a supply source connected to each of the first and second nozzle members for simultaneously supplying substantially identical pressurized streams of carrier fluid and abrasive particles to both nozzle members for effecting simultaneous discharge from the nozzle members of substantially equal but opposed high-velocity streams of abrasive media defined by

said carrier fluid having said abrasive particles entrained therein, whereby the opposed discharged streams directly impact one another within the interior chamber to cause the streams to be deflected radially outwardly for high energy impact against the boundary walls of the interior chamber.

38. (New) A process for treating the boundary walls of an interior chamber formed in a workpiece, comprising the steps of:

providing a workpiece having an interior chamber;

providing the workpiece with first and second aligned access openings which communicate with opposite ends of the interior chamber;

providing first and second substantially identical elongated nozzle members having discharge openings at tip ends thereof;

inserting the first and second nozzle members into the interior chamber through the respective first and second access openings so that the nozzle members are substantially aligned and the discharge openings thereof are positioned in closely adjacent and directly opposed relationship to one another and define an unobstructed gap therebetween;

simultaneously supplying substantially identical streams of pressurized blasting media, as defined by a pressurized high-velocity carrier fluid having solid abrasive particles entrained therein, to the discharge openings of said first and second nozzle members;

simultaneously discharging substantially identical and substantially cylindrical opposed high-velocity streams of blasting media from said discharge openings of said first and second nozzle members so that the discharged cylindrical streams, almost immediately after discharge, directly impact one another within said gap and cause the blasting media of both streams to be deflected radially outwardly in substantially perpendicular relation to the flow direction of the discharged streams to define a surrounding annular pattern



for high energy impact with the boundary wall of the chamber in surrounding relationship to the gap; and

simultaneously moving the nozzle members, while maintaining them in stationary relationship to one another, lengthwise along the interior chamber parallel to the discharge direction so that the blasting media as deflected outwardly into the annular pattern progressively treats the boundary wall of the interior chamber.

39. (New) The process according to Claim 38, comprising the step of initially positioning the opposed discharge openings of the first and second nozzle members with a gap therebetween of no more than about one inch.

40. (New) A process according to Claim 38, including the step of terminating the entrainment of abrasive particles in the high-velocity carrier fluid while continuing to supply the pressurized carrier fluid to the nozzle members as they are synchronously moved within the interior chamber to effect removal of abrasive particles and debris from the chamber.

41. (New) A process according to Claim 38, including the steps of:

providing the workpiece with at least one passage which communicates with and extends transversely from said interior chamber; and

modifying the movement of the nozzle members when the gap is substantially aligned with the transverse passage so as to permit the deflected annular pattern of blasting media to enter into and effect surface treating of the transverse passage.

42. (New) A process according to Claim 41, wherein the movement of the nozzle members is modified so that the nozzle members pause or move at a slower speed when the gap between

the nozzle members is substantially aligned with the transverse passage.

43. (New) A process according to Claim 38, including the steps of:

providing the interior chamber within said workpiece with a radial outward enlargement along a part of the length thereof; and

simultaneously moving the first and second nozzle members linearly lengthwise of the interior chamber first in one direction and then in the opposite direction while continuing to discharge opposed identical streams of blasting media therefrom so that the outwardly deflected annular pattern treats transitional surfaces which join radially between the enlargement and the interior chamber.

44. (New) A process according to Claim 38, including the steps of:

providing the interior chamber within said workpiece with first and second chamber portions in aligned communication with one another, said second chamber portion being of larger cross section than said first chamber portion; and

modifying the movement of the nozzle members when the gap therebetween moves from said first chamber section into said second chamber section so that the nozzle members move at a slower speed lengthwise of said second chamber section than when moving lengthwise through said first chamber section.

45. (New) A process for treating the boundary walls of an interior chamber formed in a casting, comprising the steps of:

providing a casting having an elongate interior chamber therein which is at least partially closed at opposite ends thereof by walls of the casting;

providing the casting with first and second aligned access openings formed in walls of the casting for respective

communication with opposite ends of the interior chamber, said access openings being of smaller cross section than said interior chamber;

providing first and second substantially identical elongate nozzle members having substantially identical discharge openings at tip ends thereof, the elongate nozzle members having a small exterior cross section which substantially uniformly extends from the tip ends of the nozzle members lengthwise thereof over a substantial lengthwise extent so as to permit the nozzle members to be inserted through the access openings;

providing first and second movable supports which engagingly support the nozzle members at a location spaced remote from said tip ends so that the first and second elongated nozzle members are respectively cantilevered outwardly from the first and second supports in generally aligned, opposed and spaced relationship to one another;

positioning said first and second supports on opposite sides of the casting so that the nozzle members are in opposed and aligned relationship with one another with the tip ends of the first and second nozzle members being respectively positioned adjacent and in generally aligned relationship with said first and second access openings;

relatively moving the first and second support members toward one another so as to insert the first and second nozzle members into the interior chamber through the respective first and second access openings so that the nozzle members are substantially aligned and the discharge openings thereof are positioned closely adjacent and in directly opposed relationship to one another and define a small unobstructed gap therebetween, the nozzle members being entirely supported by and cantilevered from the respective supports when positioned within said interior chamber;

simultaneously supplying substantially identical streams of pressurized blasting media, as defined by a pressurized high-velocity carrier fluid having solid abrasive particles

entrained therein, to the discharge openings of said first and second nozzle members;

simultaneously discharging substantially identical and opposed high velocity streams of blasting media from said discharge openings of said first and second nozzle members so that the discharged streams, almost immediately after discharge, directly impact one another within said small gap and cause the blasting media of both streams to be deflected outwardly in substantially perpendicular relationship to the flow direction of the discharged streams to define a surrounding annular pattern for high energy impact with a boundary wall of the interior chamber in surrounding relationship to the small gap; and

simultaneously moving the nozzle members, while maintaining them in stationary relationship to one another, lengthwise along the interior chamber parallel to the discharge direction so that the blasting media as deflected outwardly into the annular pattern progressively treats the boundary wall of the interior chamber as defined in the casting.

46. (New) The process according to Claim 45, comprising the steps of:

initially positioning the opposed discharge openings of the first and second nozzle members with the small gap therebetween of no more than about one inch; and

after the boundary wall of the interior chamber has been treated with the abrasive media, terminating the entrainment of abrasive particles in the high velocity carrier fluid while continuing to supply the pressurized carrier fluid to the nozzle members as they are synchronously moved within the interior chamber to effect removal of abrasive particles and debris from the chamber.

47. (New) A process according to Claim 45, including the steps of:

providing the casting with at least one interior passage which communicates with and extends transversely from said interior chamber; and

modifying the movement of the nozzle members so as to pause or slow the movement of the nozzle members when the small gap is substantially aligned with the transverse interior passage so as to permit the deflected annular pattern of blasting media to enter into and effect surface treating of the transverse interior passage.

48. (New) A process according to Claim 45, including the steps of:

providing the interior chamber of the casting with first and second elongate chamber portions which are in aligned communication with one another, said first chamber portion being of smaller cross section and said second chamber portion being of larger cross section; and

modifying the movement of the nozzle members as they move lengthwise of the interior chamber so that the nozzle members move at a slower speed when the small gap is disposed in said second chamber portion in comparison to the speed of the nozzle members when the small gap is moved along said first chamber portion.